

Section A5
Alternative 5, Advanced Composite Materials

Recycling Facility of the Month



In the heart of the 'frozen tundra' of Green Bay, Wis., this plastics recycler has made big gains in a low-margin area of recycling.

processing plastics in PACKERLAND



Fast Facts: Catenation, Inc.

Location: Green Bay, Wis.

Square Feet: 50,000

President: Randy Tess

Feedstock: 100% post-consumer plastic containers

HDPE washline installed: 1993

PET washline installed: 1998

Sorting systems handle: colored or natural HDPE; HDPE mixed bales; PET and HDPE; 1-through-7 mix; and mixed PET.

Title Town, U.S.A., home to the Green Bay Packers, "cheeseheads," and paper mills galore, is also the home of Catenation, Inc., a privately held recycling company dedicated to the recovery of post-consumer plastic containers.

Breaking ground in the land of Lombardi, a place football fans endearingly call the "frozen tundra," might not sound easy, but once Catenation opened its doors in 1993, it grew so quickly that its expansion came three years ahead of schedule. In January, the company moved shop, staying close to the original building in Green Bay, Wis., but tripling its size to 50,000 square feet and installing its first polyethylene terephthalate (PET) plastic washline.

By Heidi Ridgley

Ridgley is reporter/markets analyst for Waste Age's Recycling Times.

Catenation's decision to delve into the world of PET comes after successfully processing and then marketing natural and pigmented high-density polyethylene (HDPE) resins to a variety of extrusion, injection, and blow-molding operations across the U.S. and Canada.

"Our plan was to develop a system for HDPE, do it correctly and then back into PET pelletizing," says Randy Tess, the company's president. But what makes the company stand out from the pack is its ability to separate and sort material from a commingled bale. "We cut our teeth on the segregation of mixed bales of plastic," Tess says. "It's our claim to fame."

It also may give the company a competitive edge. "Regardless of the bale composition, we can process it," Tess says.

Catenation's success stems from its ability to consistently produce high-quality resin at a competitive price. "My job is to take feedstock from community collection and make my customers thrilled to get it over and over again," Tess says.

To fulfill his obligation, clean sorts are an absolute must. Tess says he developed Catenation's sorting system because he had a hard time relying on the sorting capabilities of other MRFs. "If they had a bad sorting day, the

potential for contamination here was too great a risk," Tess says. Now, his tactic is to convince MRFs not to waste time sorting plastic. They know paper is their big ticket item, anyway, he says, and plastics are always only an afterthought. "I tell the MRFs, concentrate on sorting the higher grades of paper and I'll do the plastic for you."

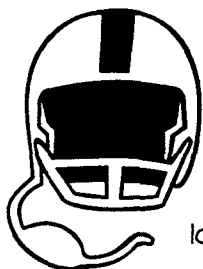
Scanning & sorting

Catenation uses custom-made, high-speed, computer-driven vision equipment to scan and sort every bottle by category. The computer even can be programmed to distinguish soiled jugs from clean, a selling point for buyers of resin who are insistent on receiving high-grade material.

"Some companies that buy feedstock from us don't want resin from jugs that may be greasy from hitting the side of the baler," Tess says. In this case, the computer is told what percentage of the containers must be free of dirt, grease, or labels.

Sorting containers, done manually during the first two years of operation, used to take 15 workers. "With people, our accuracy was unbelievably poor," he says. "It killed us economically." Now the company employs 50 people, but it is also 20 times larger—with a capacity to

Packers—not just a football team



Catenation's success comes from its ability to capitalize on its location. Although President Randy Tess's inspiration for the business came while living in Milwaukee, he quickly realized that Green Bay, with its abundant paper mills and packing companies, was the trucking hub of Wisconsin. With attractive backhauling rates—toilet paper out, plastic

bottles in—Catenation belonged in Green Bay. The company receives material from materials recovery facilities (MRFs) all around Wisconsin and the country, with a semi-trailer load coming in each week from the local MRF in Brown County, Wis.

The location also ensured Catenation's steering committee would be peppered with directors seasoned with experience from the paper recycling industry. "The

technology between plastic and paper recycling is different, but the economics are similar," Tess says. "They've already gone through the learning curve for paper recycling. They've seen things plastics recycling hasn't seen yet, but through their synergies, we've been able to glean what they've learned and bring it into the plastics world." ■

—HR

process in excess of 70 million pounds of plastic a year—and runs 24 hours a day, seven days a week.

Few employees, if any, ever actually touch the bottles during the sorting process anymore. But back in the early days—just a few short years ago—hand-sorts involved only commingled bales of natural and colored HDPE, which were processed into pellets. The company began automating once it started sorting mixed PET and HDPE bales, selling the PET unwashed. To end the contamination problems posed by polyvinyl chloride (PVC), which looks similar to PET, Tess installed several PVC detection systems made by Magnetic Separation Systems (Nashville, Tenn.).

From there, the company expanded its capabilities to a plastics Nos. 1 through 7 sort. Catenation now has a separate sorting system dedicated to five different categories: colored or natural HDPE bales; HDPE mixed bales; PET and HDPE; 1-through-7 mix; and mixed PET.

Despite such intensive sorts, little plastic gets landfilled, Tess says. Generally, even the harder-to-market plastic grades, such as those found in yogurt containers, find a home. PVC—currently his only problem—is discarded. Tess says that in a bale of plastic containing Nos. 1 through 7, he hates to see more than 8% of it contain plastics other than HDPE or PET, though he admits he sometimes sees up to 15%. And although his system is able to handle bales containing only 3-through-7s, Tess is not overly excited about processing it. "I'm not jumping up and down saying 'send it to me,' but when it comes, I can find a home for it," he says.

Deer legs and debaling

The whole process from sort to pellet begins when forklifts made by Clark (Houston) and Toyota (Torrance, Calif.) dump bales up to 1,000 pounds into the debaler. Trommels turn through the plastic, sorting out glass, caps, aluminum, and steel, which drop to the conveyor belt and get taken to the landfill. Tess says each bale is different, but on the whole the industry must dispose of about 1% to 4% of non-plastic material shipped from materials recovery facilities (MRFs).

Aside from the usual bottle caps, aluminum cans, and paper contaminants, Tess and his workers have encountered live ammunition, dead pets, and deer legs during hunting season. "You see the strangest stuff in bales," Tess says. "So you better be set up for it and be flexible."

From there, the plastics are sorted by category, granulated, and washed. Then, the material is dried and pelletized. Catenation also blends the flaked material to ensure a consistent density and eliminate dramatic shifts



After granulation, plastics move through the materials cyclone and into boxes for shipment.

in color. The company prides itself on its ability to provide end users with 40,000-pound loads containing the same appearance and properties from front to back.

The 'missing link'

Catenation sprang up after the Wisconsin legislature decided to implement a law requiring the recycling of all plastics grades 1 through 7 by 1995. Most municipalities launched into recycling PET and HDPE grades right away. "There was a lot of publicity about recycling following Earth Day [in 1990] and the [Wisconsin] Department of Natural Resources demanded that HDPE and PET not be landfilled," Tess says.

But before long mountains of the material began to pile up, Tess says. Manufacturers of plastic products wanted only clean, high-quality resin and preferred virgin or post-industrial scrap. "They viewed post-consumer material as a bad idea," Tess says.

Catenation became the missing link between the recovery of post-consumer plastics and its eventual use in high-quality products. In fact, the company's name, taken straight from Webster's New World Dictionary, defines catenation as "the process of forming into links or chains."

With the help of low-interest loans and grants from the state, which generates funding through a recycling surcharge paid by businesses, the company set off to live up to its name. By 1995, recycling of HDPE and PET was going strong, but the 3-through-7 portion of the law was put on hold once lawmakers realized that the volume generated by those grades was too small to make recovery efforts worthwhile.

Tess reasons that with such a huge volume of HDPE and PET in the waste stream, going after other plastics could jeopardize already established and successful recov-

ery systems. Besides, he adds, it makes more sense to chase the bigger piece of the pie.

"Collecting 3-through-7s may look good theoretically, but realistically, the volume opportunity for diverting waste from the landfill exists in numbers one and two," he explains. While the law is not completely off the books, it seems unlikely it will ever take hold, according to state officials. "I wasn't a fan of the 3-through-7 law," Tess says, "but we could have done some great things if it had been implemented."

Instead, Catenation jumped into PET processing—setting up a washline and pelletizing capabilities—because it became the "next logical step...and because the state made us an offer we couldn't refuse." With PET markets fizzling following the 1995 price surge for all recyclable commodities, the state was looking for a way to boost PET markets.

"We penciled a plan showing state officials we'd go the same route as we did with HDPE," Tess says. "No one was giving PET a life, but we said we think we could do

something about it."

In capitalizing on the goodwill of the state, one question begs to be asked: Can the company survive on its own? Tess says the state enabled Catenation to begin operations, but that now it is fully able to survive on its own economically. "We got help from the state to go through the learning curve, but now we've proved ourselves. And in the great scheme of things, whether a loan is made at 4% or 8% interest, it isn't going to make or break you," Tess says.

He says he feels secure in the business because he knows what to expect when markets hit the low end of the curve: "We're not like others who jumped on the band wagon at the top and then discovered problems after it was too late. We're here to survive at the bottom."

He adds, "Our product speaks for itself more than adequately. That makes us set on either end of the curve." And with the washline up and running this spring and the PET market looking hotter than it has been in awhile, Tess says, "We got dumb lucky. Our timing was just good." ■

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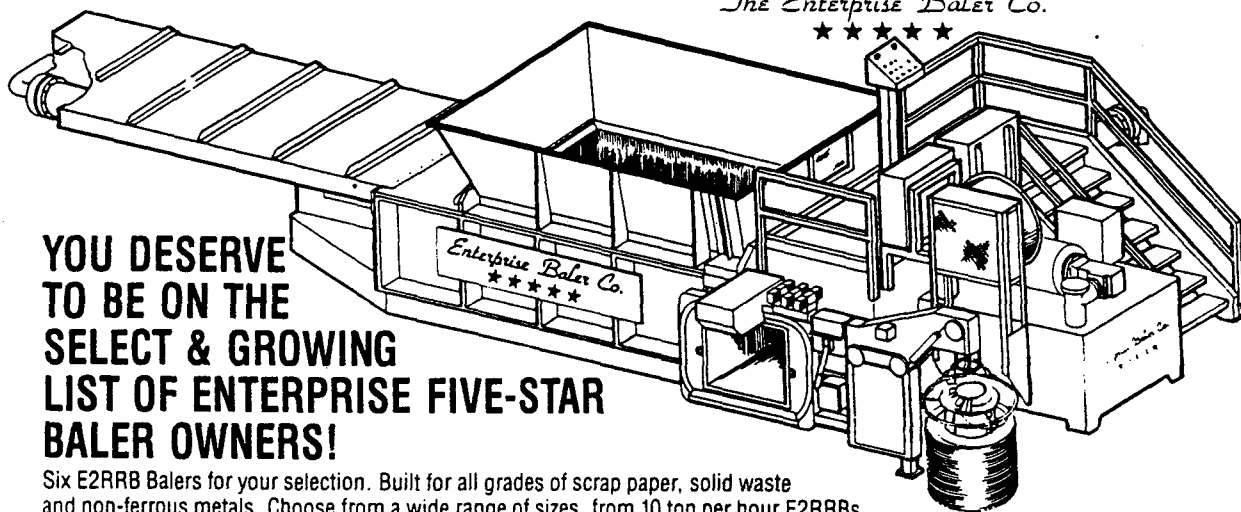
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No. 2

Vinyl Products Used in HF-HI Building Project

Nonmetallics

mittee, described wax marking "as a first step to ensuring a long and prosperous relationship with shippers, growers and grocery retailers."

PLASTICS

■ VINYL PRODUCTS USED IN HFHI BUILDING PROJECT

Scrap from vinyl siding will be ground for recycling at the upcoming Habitat for Humanity International (HFHI) Jimmy Carter work project in Houston, according to the Vinyl Institute, Morristown, N.J. Partnership for Humanity, a coalition of vinyl industry trade associations and companies, is sponsoring the construction of homes and donating volunteer time, construction funds and/or vinyl building materi-



als. The Jimmy Carter work project in Houston will take place in mid-June.

In other vinyl news, Nicos Polymers & Grinding, Easton, Pa., is using a proprietary separation technology to divert more than 25 million pounds of vinyl scrap from landfills each year. The company recycles a wide stream of vinyl waste, including vinyl-backed carpets and floor mats and reinforced vinyl garden hoses. The vinyl regrind Nicos sells to its customers is typically used to manufacture products with 25 to 75% recycled content. The company also recycles flooring, roofing membrane and blister pack.

■ SOY FLOUR LOOKED AT AS POLYURETHANE INGREDIENT

Researchers at the University of Missouri-Columbia are developing water-blown rigid polyurethane foams containing soy flour. In addition to improved physical properties, the cost of the foam formulation may be less than starch-based formulations.

"This could have a major impact on the way Americans use two different types of rigid plastics - high-density and low-density," says Fu-hung Hsieh, lead researcher on the project.

The researchers say the soy-based foam has outstanding insulation properties and, because it does not warp, it would have applications in picnic coolers, refrigerators, soda pop machines and building insulation.

"It is also environmentally correct because it may replace some petroleum-based chemicals currently being used in plastic manufacturing, and is good for the American farmer," says Hsieh.

■ SOY RESEARCHED FOR PLASTIC BAGS

Soybeans are also being examined in another plastic research project. Biodegradable plastic film that uses soybean protein and oil is being developed for use in lawn, leaf, trash and carryout bags and agricultural mulch film. The research is being led by Ramani Narayan

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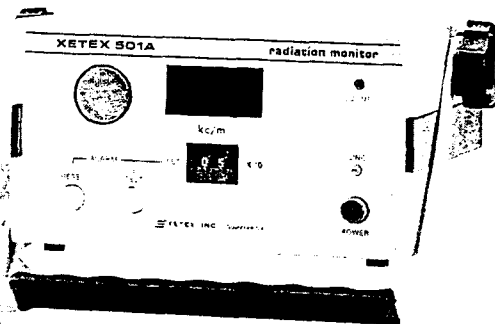
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No. 3

Enhancing PET Sorting

Enhancing PET Sorting

Magnetic Separation Systems, Nashville, TN, is working with Amoco Chemicals and Shell Chemical Co. to develop a technology to automatically sort bottles containing polyethylene naphthalate (PEN) polymers from bottles containing polyethylene terephthalate (PET).

Separating bottles containing PEN content would be useful because of PEN's higher commercial value and because it would allow reclaimers the ability to control the level of PEN in the PET, as needed for some recycling. PEN polymers are used in fabricating containers for drugs, food and beverages. The PEN content in plastic bottles ranges widely, from 5 to 100 percent.

A first generation PEN sensor was field tested at throughputs of 1,500 to 2,500 pounds per hour for four types of baled containers with various PEN content. During these tests, the sensor sorted bottles in MSS' BottleSort® equipment at 80 to 85 percent efficiency. Manual labor systems using fluorescent light as an aid typically reach only 75 to 80 percent efficiency.

The PEN sensors are being improved before a second phase of demonstrations, which begin in August at Wellman. The objective for the next demonstration is to attain sorting efficiencies of 90 to 95 percent—similar to those achieved by optical systems already in commercial use. For more information, contact MSS at (615) 781-2669.

Leachate Recirculation of a Different Character

American Technologies Inc. (ATI), Oak Ridge, TN, and the Southeastern Technology Center (STC) of the Savannah River Site have completed a demonstration of a leachate recirculation technology that makes use of indigenous bacteria to help speed waste degradation. The technology differs from most recirculation systems in that it uses air injection to create aerobic conditions instead of relying on the anaerobic conditions typical for waste degradation in a landfill. Results of the demonstration at the Baker Place Road landfill in Columbia County, GA, may encourage greater use of leachate recirculation and provide impetus for states to remove barriers to the practice.

ATI performed the demonstration

under contract to STC, a nonprofit agency of the Department of Energy. The county is now seeking approval from state regulators to continue using the recirculation technology at the site. Meanwhile, STC is also recommending the technology for the new Three Rivers landfill being developed at the Savannah River Site in Aiken, SC. The 285-acre landfill, which began construction in June, will receive municipal waste from eight counties.

In the Columbia County demonstration, ATI recirculated leachate and injected ambient air into the gravel leachate collection layer of an 8-acre section of the 16-acre landfill. Air was injected through the existing leachate collection piping system. The combination of moisture and oxygen stimulated natural microorganisms, improving the breakdown of soluble toxic materials in the refuse.

The county hoped the technology would improve leachate quality; reduce methane generation and increase rate of settlement in the landfill, thus creating more air space and extending the life of the facility. To date, says ATI's Mark Hudgins, two of the three have been proven, but the project is too young to have shown much settlement in the test cells. Another assessment will be made this fall.

The recirculated leachate contains up to 90 percent fewer contaminants than the control leachate. Biological oxygen demand concentrations, for instance, were reduced by more than 80 percent (1,100 ppm to less than 200 ppm) in less than two months of operation. The system also decreased production of both carbon dioxide and methane. Methane concentrations in the landfill's gas emissions dropped from concentrations between 40 and 55 percent to between 5 and 10 percent in the test cells.

A concern of using aerobic systems in the past has been controlling temperatures (to prevent spontaneous combustion). The demonstrated system showed that operators could inject as much oxygen as they needed to promote biodegradation while maintaining temperatures in the range of 80 to 140°F—temperatures similar to MSW composting. Hudgins said that results also suggest that the elevated temperatures can dry the leachate, thus reducing overall leachate generation, in contrast to conventional recirculation projects. For more information, contact Mark Hudgins at ATI's Aiken, SC office, (803) 643-8802. ◆◆

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No. 17

Organics Processing

(California Standards for

roadside erosion control with mulch)

configurations as well; the more sophisticated using hammer mills, trommel screens, magnetic and eddy-current separators, as well as air classifiers to pneumatically separate targeted materials.

If there's any single characteristic that MSW professionals are seeking in MRF processing hardware, it's flexibility. That's because from forklifts to balers and beyond, equipment that can handle a wide variety of tasks efficiently is likely to deliver the biggest bang for the buck. However, there's still plenty of room for more specialized equipment such as air classifiers and eddy-current separators, provided you've got the wastestream to support their long-term use.

In keeping with the quest for flexibility, most modern MRFs are being built adjacent to other MSW activities. One community that has taken this approach and run with it is Chicago. According to Bill Abolt, assistant commissioner in the municipality's department of environment, "What has happened in the city over the last 15 years is landfills that have been the primary place where our garbage has gone have closed down, and transfer station capacity has not kept pace with landfill closures." As a result, he says, "We were left transferring garbage on open lots at abandoned incinerators throughout the city." All that is changing, however, with the opening of the city's four sorting centers early this winter. "The approach is kind of one-stop shopping for the city's department of streets and sanitation," Abolt explains. Accordingly, each of the municipality's approximately 150,000-sq. ft. facilities incorporates processing lines for both mixed waste and source-separated "blue bag" recyclables, along with baling equipment and a host of other machinery. For example, Abolt says, "Each plant has over two miles of conveyors in it." Along with air classifiers and magnets, he adds, "We have two huge mixed-waste trommels that in fact had to be installed before they built the building" because they were so large. Perhaps equally noteworthy is the city's use of a bag opener that Abolt says allowed the program to process some 70,000 blue bags in its first week of operation.

Palm Beach County Solid Waste Authority's North MRF serves a population of roughly one million residents spread out over what probably is the largest county east of the Mississippi in terms of square mileage. Located across the street from a sizable WTE plant, the North MRF relies rather heavily on a system that includes air classifiers and an eddy-current separator. The first air classifier separates plastic and aluminum from the glass. Later, an eddy-current separator uses reverse magnetic charges to propel aluminum onto its own conveyor, which takes this material to the appropriate hoppers and baling equipment. Although the air classifiers and eddy-current equipment are single-purpose machines, they deal with a constant demand, cutting substantially the

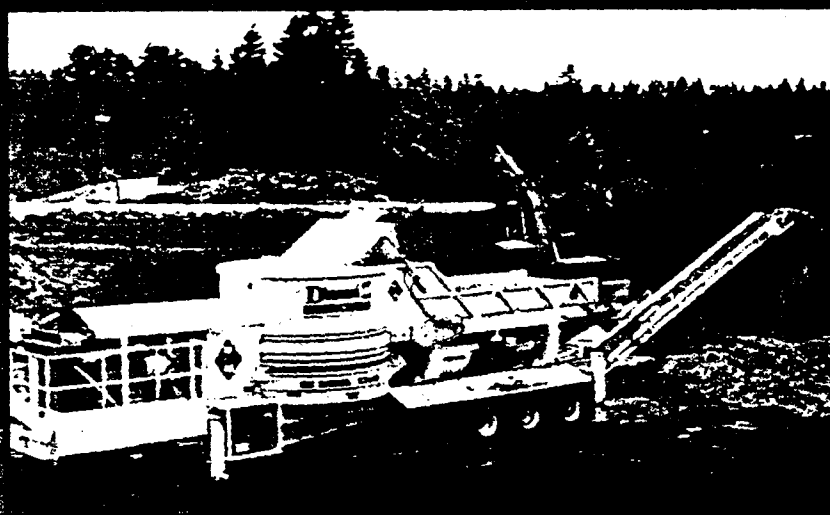
equipment for manual handling. Nonetheless there may always be a need for some level of manual sorting, particularly in separating grades of paper.

Organics Processing

The popularity of curbside greenwaste collection programs has led to the installation of organics processing facilities in an increasing number of municipalities. Grinding and mulching machines are used to produce wood chips and mulches for soil amendments, or as feedstocks for composting. Composting facilities

range in size and approach from small static pile operations and large open-air windrow composting activities to enclosed in-vessel composting plants. Finding markets for mulch and composted materials is an ongoing challenge almost everywhere, but there are signs things are changing. In California the state's department of transportation has closed ranks with the California Integrated Waste Management Board and developed specifications for the use of mulched green resource for roadside erosion control. That makes the point not so significant but merely the concrete evidence.

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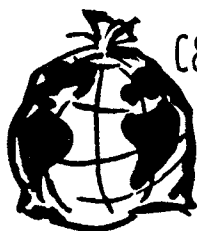
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No. 18

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Purpose-Designed Equipment Ready for Infrastructure Recycling

Essentially the concept of infrastructure recycling involves the notion of processing redundant construction materials, such as concrete, brick, and asphalt from demolition sites in order to produce new construction materials of a quality equal to that of virgin materials.

By Steve Minett, PhD, Minett Media

Recycling materials from the demolition of buildings, roads, and other forms of infrastructure is potentially a new business growth area. Companies are now beginning to develop equipment designed specifically for this use. For example, Svedala, a global supplier of mining and construction equipment, has produced a two-unit, mobile plant which is purpose-designed for this activity. Starting with a pilot project in southern Sweden, they're hoping that this equipment will make them a major international player in this market.

Holland was an early leader in the development of infrastructure recycling. This business area was established there in the early 1980s and it has been a serious business for the Dutch for about the last 10 years. Svedala equipment was installed in Holland's first infrastructure recycling plant in 1983. A second national leader in the area has been Denmark. A major example there was the recycling of the runway at Copenhagen's Castrup airport. This took place between 1985 and 1986. The recycled material from the old runway was used in the construction of a new, longer runway.

In 1990 an infrastructure recycling company was set up in the Copenhagen area and called RGS 90 (Recycling Raw Materials in Danish). RGS 90 is owned 20% by Copenhagen City Council and the rest by construction companies.

Today about 84% of building materials in the Copenhagen region are recycled. In Holland the current figure is around 60%. It should be noted that both these countries have few natural raw materials and both are small and flat; i.e., lacking in



suitable sites for landfills. In North America, California is the leader in infrastructure recycling but several of the eastern States are also getting started.

A New Business Area

Essentially the concept of infrastructure recycling involves the notion of processing redundant construction materials, such as concrete, brick, and asphalt from demolition sites in order to produce new construction materials of a quality equal to that of virgin materials. "Traditionally

only materials such as metals and, more recently glass and paper, have been recycled whereas redundant construction materials have been dumped at sea or in landfill sites," said Bo C. Persson, General Manager of Svedala's Waste Processing & Recycling Business Line: "A combination of legislation and economic incentives is now changing this picture. The EU (European Union) directive on waste encourages infrastructure recycling as will the system of taxing the extraction of raw materials which will soon be wide spread in the industrialized world."

Another form of economic incentive is the prices paid for disposal of materials. In the Copenhagen region, for example, the cost of disposal for mixed demolition materials is approximately \$100 (U.S.) per ton. Whereas a "pure" consignment of waste concrete can be deposited with RGS 90 (for recycling) at a cost of only \$5 (U.S.) per ton.

Mats Tarring, from the Danish consulting engineers, Demex, said, "This price structure has definitely had an effect, over the last five years, in changing the behavior of demolition companies in Denmark. They now sort materials into their respective groupings; concrete, asphalt, brick, rather than mixing it altogether. This change in demolition practice is obviously a necessary development for effective recycling."

Swedish Pilot Plant

In the Malmö area of southern

Sweden, a pilot plant for infrastructure recycling has started. In cooperation with the pilot plant operations, purpose-designed equipment, the Svedala Infracrusher and Infraseparator, has been supplied to an organization called Sysav, which is owned by nine local authorities in the area. Like the Danish company, Sysav offers different prices for pre-sorted materials; the better the incoming material is from a recycling point of view, the lower the price the depositor has to pay.

These prices are now the same for materials to be deposited in the landfill where Sysav's recycling plant is located, so the incentive to pre-sort materials operates consistently.

The rebar which is extracted from concrete during the process emerges clean enough to be sold as scrap steel. Another new material is crushed brick and tile. Its load bearing properties are not up to the level of concrete and asphalt, but it has proved suitable for constructing cycle and pedestrian paths.

Traditional backfill material is also produced from the coarser grades of unsorted demolition materials. The process also extracts what is known as "fluff," which consists of plastics, wood, and fabric. These are burnt in the nearby district heating plant. A residual by-product is known as "natural fines," which is mainly soil. This is deposited in the landfill.

Potential Major Market

This venture with Sysav is, in effect, a field test of this purpose-designed ... equipment. Person said, "[w]e set up our business unit for infrastructure recycling in 1995. [We see] this as a very significant global market ... the equipment required in this area is basically the same as that ... supplied to the mineral processing industry The major differences being, of course, the low level of homogeneity in the material and its contamination by other materials such as plastics, wood, fabrics, soil, and rebar in concrete."

Mobile Plant

This purpose-designed equipment is, in effect, standardized units which comply with European and U.S. standards. First among their advantages is their mobility. Both units can be mounted on tires, crawlers, or loaded onto a low-loader. This essentially means that the equipment can be taken directly to major demolition sites. To achieve mobility, the equipment has been constructed from relatively lightweight materials.

Another important feature is that the conveyor belts, used on both units, can be packed away for ease of transport. They are also easy to set up on site.

Turning to the actual process, an important advantage of the Infracrusher is the extent to which "fines" (mainly soil) are removed before crushing. The feeder leading to the crusher is unusually long. The feeder has a steep angle and contains a step, which generally turns over the larger pieces of concrete.

A vibrating screen shakes free soil and other debris. This pre-crushing cleaning stage improves the quality of the final product. An added feature of the feeder is its wear bars at the end which prevent obstruction.

The Infracrusher is equipped with an impact which has 'S' shaped hammers that are reversible and replaceable. Air stripper bars reduce dust and, therefore, wear, and the crusher also has several other replaceable wear parts. The faster the hammers rotate the finer the fraction produced. The hammer's rpm can be steplessly set between 300 and 450.



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No. 19

Working to Use Fly Ash Beneficially

(structural lumber)

Hollander, H.I. and A.L. Plumley. "Vitrification of Combustion Ash Residue for Beneficial Use." *Solid Waste Technologies*, May/June 1995.

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Provide Solutions
October 1991.

Rogoff, M.J.. "Current Developments in MWC Ash Management." Proceedings of the 29th Annual International Solid Waste Exposition, August 1990. Vancouver, BC, Canada.

Marc J. Rogoff is a vice president for HDR Engineering Inc., 5100 W. Kennedy

States
Power.

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Working to Use Fly Ash Beneficially

Fly ash, the residual that is captured from the flue gas stream when combusting waste or coal or other solid fuel, may be on its way to boosting economic growth in the Hudson Valley of New York. The New York State Energy Research and Development Authority (NYSERDA) is sponsoring a project with Ecomat Inc., Poughkeepsie, NY, and Central Hudson Gas & Electric to incorporate fly ash into foamed structural lumber products that will replace building materials in some applications.

As indicated in SWANA's ash survey, WTE plants pay an average of \$40 per ton to dispose of their ash, a rate similar to what utilities pay nationwide. NYSERDA is hoping to demonstrate that "with a little innovation and forward thinking," economic growth problems and environmental problems can be solved simultaneously.

Ecomat established a pilot facility in Poughkeepsie to demonstrate its manufacturing of foamed thermoset structural lumber products. The products would be used to replace items currently made from wood. An advantage of fly ash lumber is that, unlike thermoplastic based lumber, it will not distort when exposed to sunlight, according to Ecomat executive vice president John Mushovic. The project will initially concentrate on ash from a single utility, Mushovic indicates, to keep feedstocks consistent. However, a successful demonstration could lead to exploring the use of other types of ash, including that from MWCs. The demonstration and report should be completed by fall of 1997.

The National Association of Home Builders Research Center will test several prototype products for structural integrity and adherence to code. The most promising of the prototypes will then be developed and evaluated at the pilot facility. If successful, Ecomat will sell licensing rights to other building product manufacturers.

For more information, contact Gary Davidson, NYSERDA, 518-862-1090 or John Mashovic, Ecomat, (914) 473-8777.

Fly ash can also be used to manufacture zeolites for the chemical industry

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IV. EXISTING RECYCLED WOOD WASTE PROCESSORS AND USERS

INTRODUCTION

There are presently nine businesses in the northeast that separate wood from the waste stream and process the wastes for use as fuel. Two of the businesses also process wood wastes for use as landscaping mulch, which supplements existing markets for wood fuel. Several of the businesses are exploring additional markets for processed wastes, including the use of wood wastes as soil amendments, as a binding agent for municipal sludge that will be landspread, and as a wood supply for industries that manufacture particle board and other building materials from wood waste products.

None of the existing recycled wood waste processors use processed wastes on-site for fuel, although that will change in the near future. One processor in New York is well along in the planning and permitting process for a wood waste combustion and cogeneration system. Other processors have considered it, and may make the capital investment needed if they can negotiate attractive power sales agreements with their local electric utility.

Of the nine processing businesses currently in operation, five were previously involved in the hauling and disposing of wastes. The remaining four businesses were developed solely for the purpose of processing and selling wood wastes. There are two wood waste processing operations known to be in the planning stages, and there may be more that were not identified in the research. One is located in Boston while the other is located outside of New York City. Both businesses are presently involved in the hauling and disposing of wastes.

At the present time, there is one 43-MW, wood-fired facility in New York that relies on recycled wood wastes as a primary source of fuel. Other wood-fired facilities that purchase recycled wood wastes for fuel currently use recycled processed wood to supplement harvested chips and mill residues. One refuse-to-energy facility operating in Maine is purchasing recycled wood wastes to burn with municipal solid waste. This pattern may increase as additional refuse-to-energy plants come on line in the future.

Several major wood chip brokers in New England are exploring opportunities for purchasing and distributing processed wood wastes through the infrastructure they use to market and deliver harvested wood chips. The brokers plan to sell recycled wood as fuel to existing wood-fired industrial boilers and small power producers. The plants will burn a mixture of harvested wood chips, mill residues and recycled wood wastes. This is particularly true in northern New England where there is substantial demand for wood fuel within a 75-100 mile radius of two recycled wood waste processors currently in operation.

There are three 13- to 32-MW small power producers in the planning or permitting stage in Connecticut for power plants that will burn a mixture of harvested chips, mill residues and recycled wood. There is a similar firm in New York in the planning phase for two or three 5-MW power plants that will burn recycled wood wastes as a primary or secondary fuel. In addition, two energy developers are exploring opportunities for developing 20- to 25-MW power plants in the Boston area that will rely on recycled wood wastes as a primary fuel. The plants may do their own processing on site. One of the firms is presently negotiating a power sales agreement with Boston Edison.

While the supply of and demand for recycled wood wastes is certain to change during the next few years, an important mechanism for understanding the current market is investigating existing wood waste processors and users. Presented below is detailed information on three facilities that currently process or use recycled wood wastes for fuel in the northeast. In addition, an annotated listing is included that provides background information on all existing and proposed recycled wood waste operations in the northeast.

Most of the facilities identified below are referred to in other sections of the report. The purpose of this section is to provide detailed information on several representative facilities and to provide reference information on other facilities in a format that is easy to use. While the primary focus of research for this report was on the eleven state northeast region from Maine to Maryland, information on facilities located

outside of the northeast is included, where available.

FUEL TECHNOLOGIES INC.

Fuel Technologies Inc. (FTI) of Lewiston, Maine converts discarded wood waste into burnable wood chips. They receive unprocessed wood waste, which is cleaned by hand, vibrating screens, and magnets, and pulverized by a hammermill into wood chips. At a time when many communities are closing landfills, this relatively new process appears to relieve part of the pressure on existing landfills.

FTI receives wood waste, processes the wood waste into wood chips, stores the chips, and eventually sells the chips to regional biomass facilities.

FTI received its first load in June 1986. The hammermill has been in operation since August 1986. The permit and licensing process with the Maine Department of Environmental Protection took four months to complete.

Plant Design and Capacity

Presently, FTI produces 200 tons of chips per day. Assuming operation for five days per week and 52 weeks per year and sufficient supply, the operation can produce 52,000 tons of fuel-quality chips per year. FTI hopes to produce 300 tons per day since the machinery is rated at 30 tons per hour.

The company's total land holdings are 10 acres. The buildings are situated on three acres with an additional two and one-half acres filled with unprocessed wood. FTI is working to reduce this backlog. The remaining land (four and one-half acres) encompasses a settling pond and unused land located near a stream.

Wood Waste Supply and Specifications

FTI accepts any load that consists primarily of wood, including pallets, cable spools, used timbers, wood demolition debris, pilings, wood manufacturing byproducts, heavy cardboard, railroad ties, and brush. FTI will not accept loads comprised of more than 5% non-wood material. FTI visually inspects every load until a working relationship is established with the hauler and reserves the right to reject any load. Creosote materials can be processed but must be sold only to customers capable of burning coal. FTI will not accept stumps because they have not found an economical way to remove rocks from stumps.

The typical load received at the plant weighs 16-20 tons. FTI receives approximately five loads per day (100 tons/day). Loads are weighed before arriving at the site at a weigh station close to FTI. Eighty percent of the wood supply is from demolition sites. The balance is 10% from pallets and 10% from shipyards.

Equipment and Material Flow

1. Materials are dumped by the wood waste generator or hauler at the plant site.
2. Material is moved to the processing or storage area by a D6 Caterpillar bulldozer with a large sprocket. To a limited degree, material can be broken apart and compacted if necessary during this procedure. A large dozer and sprocket is necessary to avoid riding over the interlocked materials.
3. A clamshell claw picks up and deposits the material into a vibrating screen with 2" holes. This screen was built by FTI and filters out small non-wooden material and dirt.
4. Non-wood material is picked out by hand. This procedure is the rate-limited step in the entire process. FTI hopes to incorporate a metal detector into this front end processing stage to minimize the need for hand picking. Ferrous and non-ferrous scrap metal is sold to outside brokers. A small quantity of unusable scrap is put into a dumpster on site.
5. A Jeffrey hammermill pulverizes the material into wood chips. This hammermill has 24,100 lb

hammers and a 600 horsepower motor.

6. A series of magnets remove ferrous materials.
7. The material rides a conveyor to the top of the storage building.
8. The material is fed through a screen that removes fine soil and dirt, which is conveyed outside and sold to a local landscaping contractor for fill and mulch.
9. The material remaining inside the storage building is primarily burnable wood chips. The moisture content is typically very dry, ranging from 7-10% except in the spring when it can be as high as 30%.
10. Processed wood chips are loaded onto trucks over a loading ramp built out of concrete.

Operation and Maintenance

Most of the hardware, including the hammermill and the conveyor belts, are manufactured by Jeffrey Dresser Industries of Woodruff, South Carolina.

Jeffrey has learned a great deal from this operation and is currently improving their machinery to meet the demands of processing wood waste. These machines were originally designed primarily to process wood without metal fragments. If FTI was to install the system again, the company would consider using equipment from the sand/gravel industry.

FTI finds that it must weld new metal hammers onto existing hammers **every night** to compensate for daily wear. FTI estimates total downtime for equipment is approximately 5% of the year.

FTI has not discovered an inexpensive method to detect and extract non-ferrous metals. Presently, they periodically inspect the bottom of the chip pile for non-ferrous metals.

Financing and Economics

The facilities at Lewiston cost over \$3 million to build, including buildings, site improvements, and engineering. The land is leased.

The tipping fee being charged to wood waste suppliers is currently \$15 per ton. The rate is lower than many area landfills and transfer stations, thus offering wood waste generators and suppliers an opportunity to reduce disposal costs.

Approximately two to three tons of wood waste are required to produce one ton of wood chips, thus the net selling price per ton of raw material received is much less than \$30 per ton. FTI finds that its price has to be lower than the \$18 per ton or more charged for whole tree chips even though its Btu content is much higher.

FTI sells the wood fuel produced at the plant for approximately \$15 per ton. In addition, the company sells material from the first screening for \$1.50 per ton and from the second screening for \$2.50 per ton.

Whenever possible, FTI arranges delivery of the wood chips, which increases the price. Transportation costs depend upon distance and whether or not the trucker can get a backhaul. They are \$1.50 per mile with a backhaul and \$2.50 per mile without a backhaul arrangement.

FTI would rather not reveal its processing costs per ton. Repair and maintenance cost \$1 per ton (\$25,000 annually to weld 100 lb of welding rod for two hours per night).

Marketing

Sources of wood waste were identified by contacting the municipal associations, town managers and selectmen, and town public works departments. In addition, over 4,000 letters were sent out to solicit material.

FTI suggests that local public works departments should be encouraged to send wood waste to the facility.

Customers

The two primary wood-burning customers are Maine Energy Recovery Company, a refuse-to-energy plant in Biddeford, Maine (which uses 80% of FTI's production) and Scott Paper Company in Westbrook and Winslow, Maine.

FTI cannot sell its chips where the presence of non-ferrous metal would cause a problem. Because the material is often kiln-dried (moisture content of 710%) many customers mix FTI chips with green chips to avoid overheating their burners.


FTI increases its market by contacting wood chip brokers and by direct calls to potential customers. However, they feel that selling chips is not as difficult as assuring a reliable supply of raw material.

For further information:

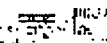
Fuel Technologies Inc.
310 Cottage Road
Lewiston, ME 04240

tel: (207)783-2941
Contact: Mark Woodbury, Manager

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Cottage Road
Lewiston, ME

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Cross Section
Fuel Technologies Inc.
Cottage Road
Lewiston, ME

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GRANITE STATE NATURAL PRODUCTS, INC.

Granite State Natural Products, Inc. (GSNP) is a wood waste processing facility located in Salem, New Hampshire. The facility is designed to process wood and wood waste materials for use as fuel by industrial and commercial wood-fired facilities. Wood wastes processed at the facility are supplied by a variety of waste producers and haulage contractors from the area including southern New Hampshire and northern Massachusetts.

The wood wastes are received in a variety of forms, including demolition debris, construction scraps, prunings and trimmings, used pallets, discarded packaging, and other woody materials. The wastes can be irregular in size, difficult to compact, and awkward to handle. Once processed at the plant, the wastes appear similar to harvested wood chips and can be used as fuel by facilities that burn wood chips and/or

mill residues for energy. They can also be used as wood mulch.

There are currently nine wood waste processing facilities under construction or in operation in the northeast. Granite State Natural Products is one of eight facilities that process wood wastes into fuel but do not use the fuel on-site. All materials produced at the plant are sold to other industrial and commercial facilities. Customers include small wood-fired power plants, industrial wood-burning facilities and commercial landscapers. Similar facilities include Fuel Technologies Inc in Lewiston, Maine; SPM Environmental, Inc. in Brooklyn, New York; Star Recycling in Woodside, New York, and AFA Pallet in Newark, New Jersey.

Plant Design and Capacity

Granite State Natural Products is designed to produce up to 500 tons of processed wood wastes per day. Additional capacity of 500 tons for processing wastes into landscaping mulch may be added in the future. The plant is designed to handle a wide range of wood waste materials. Overall, GSNP anticipates that most of the wood waste handled at their facility will be construction scraps, demolition debris, tree trimmings and prunings.

Wood Waste Supply and Specifications

Granite State Natural Products anticipates that most of their wastes will be obtained from the greater Boston area. They are actively seeking wood waste producers and haulage contractors who are interested in "disposing" of their wood wastes at the plant. They would like to develop written or verbal contracts with at least 50 suppliers in the area.

Because GSNP is the first plant of its type in the area, the company is putting substantial effort into identifying, contacting and developing relationships with potential wood waste suppliers. Many waste producing firms and haulage contractors are not yet familiar with the operation of wood waste processing facilities, and are not aware of the ways in which GSNP could be beneficial to them.

The company has developed strict quality control guidelines to ensure that the waste they receive can be processed into fuel. Specifications have been developed that require each load of waste to be at least 95% wood. The company does not accept loads with asbestos, creosoted materials, concrete rubble, large metal pieces, rubber or tar shingles. GSNP will work with suppliers to help them find alternative markets for materials not accepted by the plant.

The primary product of Granite State Natural Products is a uniform-sized wood fuel material that looks very similar to harvested wood chips. The fuel is designed for use by industries, businesses, institutions and small power producers that use wood for energy. Wood fuel produced at GSNP has a moisture content of 15-20% (wet basis) and an energy content of about 9000 Btu per ton.

Equipment and Materials Flow

1. Waste materials are inspected while on the truck at the entrance to the site.
2. Materials are emptied onto a concrete unloading pad at the plant and inspected in closer detail. Rejected loads are loaded back on the truck and sent away.
3. Accepted wood wastes are loaded with a grapple or a front-end loader onto a vibrating conveyor.
4. Materials to be processed later are put in open storage piles adjacent to the unloading area using the grapple or front-end loader.
5. Wood wastes loaded onto the vibrating conveyor are visually inspected and hand-sorted as they move along the conveyor.
6. Materials on the conveyor are transported through a large magnet to separate out a majority of the metal in the wastes.

7. Once through the magnet, the wood move along an in-feed conveyor and into the top of a hammermill.
8. Materials are processed by a large hammermill similar to those used in large pulp and paper industries but modified significantly for wood waste processing.
9. Wood wastes pass from the base of the hammermill through a second magnet that removes any remaining metal from the wastes.
10. The processed materials then pass through a double-deck shaker-screen that separates over-sized pieces (called the "overs") and under-sized pieces (called the "fines") from the processed materials.
11. The processed wood chips travel from the shaker-screen to a conveyor that loads them into the back of a truck, or into a storage hopper owned by the company. The chips are then transported to the end user.
12. The overs are fed through the hammermill a second time. The fines are collected and sold.

Operation and Maintenance

Granite State Natural Products is a state-of-the-art facility designed to be operated by a staff of six and to require minimal maintenance. Staff include

- an inspector at the entrance to the site who reviews each truck load before entering the plant,
- an inspector at the unloading pad who closely inspects materials being delivered and decides whether to reject loads once they are unloaded,
- a grapple operator who loads materials from the unloading pad and storage pile onto the vibrating conveyor,
- a control operator who manages the controls of the facility and ensures that all equipment is operating smoothly and efficiently, and
- two on-line operators who visually inspect and hand-sort the wastes as they travel along the vibrating conveyor.

All equipment used at the plant was installed new. A few modifications were made to meet the specific needs of the facility. Special attention was paid to making adjustments that would reduce maintenance requirements and downtimes. Overall, the plant engineer anticipates that operation and maintenance costs will be about \$100,000 each year, or about 10% of the total cost. The plant is designed to operate for at least 15 years.

Financing and Economics

Granite State Natural Products has spent about \$1 million on the design, construction and completion of the plant. Money was raised privately; bank loans were not required.

The tipping fee being charged at GSNP is currently \$10 per yard or about \$50 per ton. This is similar to tipping fee charged at a landfill in Kingston, Rhode Island and is lower than many tipping fees charged in the immediate Boston area.

GSNP sells the wood fuel produced at the plant for \$18-\$22 per ton, depending on the volume purchased and delivery arrangements. Sawdust produced at the plant is mixed with mulch and sold for \$7 per ton.

The company expects that the cost of processing wood wastes delivered to the plant will be equal to the price paid for the fuel produced. Therefore, any profit will depend upon the tipping fee charged at the

facility. The company anticipates being able to offer a lower tipping fee than landfills and transfer stations, because of the ability to cover their processing costs with the revenue generated from selling the fuel.

Site Selection

Granite State Natural Products is located on a 42-acre site that is licensed as a landfill. The site was previously used as a demolition waste site. GSNP does not presently plan to landfill or keep non-wood wastes at the site.

GSNP believes that it was advantageous during the local review and approval process to own a site for the plant that had once been used for waste disposal. There was some public concern about the siting of a wood waste processing plant in Salem; however, the company believes public acceptance was easier to achieve because the site had already been used for waste-related activities.

Environmental Review and Permitting Process

A variety of local and state environmental permits were required to license and begin operating the plant. Overall, it took about six months to obtain the necessary approvals. Because Granite State Natural Products is the first wood waste processing facility to be developed in New Hampshire, company personnel spent a fair amount of time providing basic information on the design and operation of the plant to local and state officials.

The company was fortunate to have on its management team both a lawyer familiar with the local community and an engineer who had been involved in the siting and licensing of similar plants in California. The team met frequently with officials responsible for reviewing the plant, and worked hard to develop an atmosphere of cooperation and mutual trust.

For Further Information:

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51 Main Street
Salem, NH 03079

tel: (603)893-2561

Contact: Dan Breton, Operations Manager, Frank V. Hekimian, Treasurer

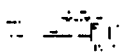
Hekimian and Associates, Inc.
16571 Gemmi Lane
Huntington Beach, CA 92647

tel: (714)841-6288

Contact: Kenneth K. Hekimian, President

Site Plan

Granite State Natural Products
Salem, NH

 [Click here to expand site plan.](#)

PROCTER & GAMBLE MANUFACTURING COMPANY

Procter & Gamble Manufacturing Company, a major consumer products manufacturer, began burning waste wood in 1983 at their Port Ivory plant, located on a 135-acre site in the northwest corner of Staten

Island, New York. Prior to converting to wood energy, the facility cogenerated steam and electricity with oil- and gas-fired boilers in order to be self-sufficient in terms of its thermal and electrical needs. This summary of Procter & Gamble's conversion experience is based on public information, augmented by telephone interviews with technical staff at Port Ivory.

Decision-Making Process

Before 1979, steam and electricity were supplied by a packaged oil/gas-fired boiler, a 3-MW diesel generator set, and a backpressure turbine. As oil and prices rose in the late 1970s and into the 1980s, Procter & Gamble wanted to increase its system efficiency to reduce fuel costs. A Thermo-Electron waste heat recovery boiler was installed in 1979. This system allowed Procter & Gamble to be self-sufficient in terms of steam, power and refrigeration, and compressed air. The Port Ivory plant has no tie-in to Consolidated Edison, the local utility. However, with prices continuing to escalate, the company decided to investigate alternative fuel sources.

With coal conversion considered too expensive and difficult to permit because of strict air quality regulations in New York City, the company investigated installing wood energy equipment. In August 1980, feasibility studies were authorized to investigate regional waste wood supplies and the economic viability of a waste wood-fired system. Reports showed wood wastes to be an alternative fuel source because of abundant supply and low cost. As a result, the corporation approved funding for a wood energy conversion in July 1981.

Description of Equipment

Procter & Gamble burns a mixture of processed wood waste and green whole tree chips. The combustion system is a 240,000 lb/hr boiler operating at approximately 900 psig. Steam is used in manufacturing processes and to drive a steam turbine. The oil- and gas-fired steam generating unit is used for backup.

Wood Fuel Selection and Supply

An important factor that affected the economics of the conversion was the decision to process and burn wood wastes being generated within the New York metropolitan area. The original wood fuel supply arrangement provided for waste wood generators and haulage contractors to bring their waste loads to the manufacturing site. A conveyor was built to transport wood from storage to a hammermill where it was hogged, screened, sized, and piled. Metal was removed by a series of electro-magnets. A key feature was a pneumatic conveyor delivering wood chips to the boiler surge bin through a 14-inch diameter pipeline. However, after experiencing severe problems with the waste processing and conveying systems, Procter & Gamble decided to stop hogging fuel on site.

Currently, processed wood fuel is purchased from wood waste processors recycling plants in the New York metropolitan region including: Hubbard Sand & Gravel, Bayshore, NY; SPM Environmental, Brooklyn, NY; Star Recycling, Woodside, NY; AFA Pallet, Newark, NJ; Recycled Wood Products, Hurfville, NJ; and NRS Carting, Norwalk, CT. In 1987, Procter & Gamble paid approximately \$16 per ton for wood fuel delivered to the facility. The moisture content of the wood is about 15%. Approximately 600 tons are burned each day.

In order to ensure that recycled wood chip suppliers deliver properly sized fuel that is free of hazardous materials, Procter & Gamble has developed specifications for delivered wood chips. Loads that do not meet the requirements may be rejected, or the price may be adjusted to reflect the quality of the fuel. The following table summarizes the specifications.

TABLE 1
PROCESSED WOOD WASTE SPECIFICATIONS

Size:	Nominal two inch dimension. Maximum size accepted is 3 inches in any dimension, with no more than 20% in the 3 inch size classification. Fines (under 1/4" dimension) must be limited to less than 25%.
Moisture Content:	Between 0-25%, not to exceed 30% (green

basis).

[Click here for table in WK1 format.](#)

In addition, Procter & Gamble requires the wood to be free of metal, stones, dirt, and other non-wood materials. Pressure-treated or creosoted wood is not accepted. The overall quality of the processed wood waste is determined by visual inspection at the plant.

Air Emissions Equipment

The air emissions equipment consists of an economizer, two-stage dust particulate removal system, and wet venturi cyclone separator. These clean the flue gas prior to exiting a 200 ft stack.

Ash Disposal

The disposal of non-combustible ash has not been a problem for the company. It is combined with particulate dust and stored in closed dumpster containers before being brought to a local landfill. However, as available landfill capacity in the New York area continues to decrease, ash disposal may become more costly.

Problems and Solutions

In addition to problems related to processing wood wastes, Procter & Gamble experienced difficulties with wood combustion. Carbonized ash and wood (clinkers) often jammed the rotary vane feeders in the dust collection system. Because of incomplete wood combustion, the fly ash was only one-third of the anticipated density and hence several times the expected volume. This resulted in a higher than anticipated ash removal rate.

Several technical adjustments were made to the combustion system to correct these problems. A tipping valve was installed in place of the rotary vane feeder valve to allow larger pieces of carbonized fly ash to flow to the dumpster, and to achieve a better air lock. Sootblowing and char re-infection systems were added to improve boiler efficiency and achieve more complete combustion. As a result, fly ash volumes were reduced by 80% by bringing the ash to its planned density.

Conclusion

In addition to the Port Ivory facility, Procter & Gamble owns other manufacturing plants in the U.S. that burn recycled wood chips for fuel. Despite widescale corporate use of wood wastes, the company prefers that most information regarding their wood burning experiences remain confidential. In a paper presented by Procter & Gamble at a 1985 conference sponsored by the Council of Industrial Boiler Owners, insights about the Port Ivory conversion were provided. Forecasted higher-fuel oil prices have not developed, decreasing estimated project savings by 50%. Maintenance and operating costs are five times the anticipated level. A Procter & Gamble representative summarized the wood energy conversion by stating that, "today, in retrospect, I can only simply say if we knew then, what we know now, the wood burning boiler project would not have been undertaken."

While it may be that the economic benefits anticipated at Port Ivory have not met corporate expectations, it is a fact that Procter & Gamble operates a wood fuel plant in California and continues to employ biomass as a fuel on Staten Island. On balance, this corporation has made an important and continuing commitment to the use of wood waste as a boiler fuel.

ANNOTATED LIST OF RECYCLED WOOD WASTE FACILITIES IN THE U.S.

Presented below is an annotated list of existing and proposed facilities designed to process or burn recycled wood wastes in the U.S. The information is organized by state, and is most complete for the Northeast region since that was the primary focus of research for this report. Where available, information on facilities in other portions of the country are included.

California

Operating Combustion Facilities

Energy Factors
3712 Feather River Boulevard
Marysville, CA 95901

tel: (916) 741-9663
Contact: Mike Lavenda, Operations Manager

This operating wood-fired boiler is rated at 180,000 pounds per hour and burns a mixture of wood chips and recycled wood wastes. The plant uses fluidized bed combustion equipment and an electrostatic precipitator.

Fibreboard, Inc.
P.O. Box 190
Antioch, CA 94509

tel: (415) 757-4000
Contact: Fred Wetzol, Biomass Fuel Manager

This lumber and wood products industry has been burning recycled wood wastes since 1981. The company is located in the vicinity of 45-50 landfills, making it relatively easy to obtain a reliable supply of recycled wood wastes.

Procter and Gamble
P.O. Box 44090-801
1601 West Seventh
Long Beach, CA 90813

tel: (213) 432-6981
Contact: Dick Rodenbach

This 140,000 pound per hour facility produces up to 13.5 MW of electricity using a mixture of wood chips and recycled wood wastes. The large volume of steam produced is used on-site in the manufacturing process.

Planned Combustion Facilities

Tamal Development Corporation
80 East Sir Francis Drake Boulevard
Larkspur, CA 94939

tel: (415) 925-1568
Contact: Paul Schleifer, Vice President

Tamal Development is in the planning process for developing 1 to 4 10-MW power plants that will use recycled wood wastes as a primary fuel source. The company is interested in locating near existing transfer stations and landfills that can provide their plants with reliable low-cost sources of fuel. Locations currently being investigated include metropolitan Boston and New York.

Connecticut Planned Combustion Facilities

ARS Group, Inc.
15 Clark Road
Wellesley, MA 02181

tel: (617) 235-8516
Contact: Peter G. Bos, President

ARS is planning a 32-MW power plant in northeastern Connecticut. The company has received approval from the Department of Public Utilities Control and is in the design and engineering phase. The plant will have an annual fuel consumption of up to 400,000 tons of recycled wood wastes, harvested chips and mill residues.

Biogen, Inc.
269 Old Canterbury Turnpike
Norwich, CT 06360

tel: (203) 822-8638
Contact: Bruce Fitzgerald, President

Biogen is in the planning and permitting stage for a 13-MW power plant in Torrington, CT that will be fueled by a mixture of recycled wood wastes, harvested chips and mill residues. The company also hopes to retrofit an existing coal-fired incinerator in Pawtucket, RI to burn a mixture of wood fuels, including recycled wood wastes.

Operating Processing Facilities

NRS Carting Company
36 Meadow Street
Norwalk, CT 06854

tel: (203) 853-2595
Contact: Robert LeBlanc

This haulage contractor processes approximately 35-40 tons of construction wood daily for sale to the Procter & Gamble plant in Staten Island, NY.

Maine Operating Combustion Facilities

Ultrasystems, Inc.
12500 Fair Lake Circle, Suite 260
Fairfax, VA 22033

tel: (703) 968-7200
Contact: Leo Bronson

Ultrasystems develops and operates wood-fired power plants throughout the U.S. They currently have six plants in operation, including two in Maine and four in California. Two new plants are presently under construction. The plants range from 10 to 25 MW, and are designed to burn a mixture of harvested wood chips, mill residues, or recycled wood wastes.

Operating Processing Facilities

Fuel Technologies Inc
310 Cottage Road
Lewiston, Maine 04240

tel: (207) 783-2941
Contact: Mark Woodbury, Manager

This operating wood waste processing facility produces 200 tons of processed wood each day. The plant will accept loads that have no more than 5% non-wood material. Processed wood is primarily sold to Maine Energy Recovery Company in Biddeford, ME and Scott Paper Company in Westbrook and Winslow, ME.

Massachusetts Planned Combustion Facilities

Energy Initiatives, Inc.
95 Madison Avenue
Morristown, NJ 07960

tel: (201) 292-9630
Contact: Michael J. Widico, Project Development Manager

Energy Initiatives is planning to build a 16-MW power plant south of Boston that would burn primarily recycled wood wastes. The electricity would be sold to Eastern Edison.

Signal Energy Systems, Inc.
Liberty Lane
Hampton, NH 03842

tel: (603) 926-5911
Contact: Chris G. Ganotis, Vice President

Signal has proposed the construction of a 25-MW power plant near Boston that would be fueled by primarily by recycled wood wastes. The electricity would be sold to Boston Edison.

Planned Processing Facilities

Jet-A-Way, Inc.
47 Kemble Street
Boston, MA 02119

tel: (617) 288-7131
Contact: Jesse Jeter

Jet-A-Way is a transfer station that is currently considering processing wood wastes for fuel.

New Hampshire Operating Processing Facilities

Granite State Natural Products, Inc.
51 Main Street
Salem, NH 03079

tel: (603) 893-2561
Contact: Dave Breton, Operations Manager

Frank V. Hekimian, Treasurer

This operating wood waste processing facility can produce up to 500 tons of processed wood waste per day. The plant accepts loads that are no less than 95% wood material. The company sells to industrial wood fuel users, wood-fired small power producers and companies requiring mulch. In late 1987, the company had secured markets for all of the wood being processed, and was actively seeking new sources of supply. Although the plant did not originally plan to accept creosote-treated material, they have found a market for landscaping mulch produced from processed creosote-treated materials.

New Jersey Operating Processing Facilities

AFA Pallet Company
514 Doremus Avenue
Newark, NJ 07105

tel: (201) 589-8336
Contact: Anthony A. Peterpaul

This firm processes wood chips for sale to the Procter & Gamble wood-fired manufacturing plant on Staten Island. The processor can generate 200-300 tons of processed wood per week.

Recycled Wood Products
P.O. Box 414
Sewell, NJ 08080

tel: (609) 589-1501
Contact: Craig Rossler

Recycled Wood Products processes wood waste into fuel for sale to Procter & Gamble on Staten Island. The plant also produces mulch for sale to local landscapers.

New York Operating Combustion Facilities

Procter & Gamble
40 Western Avenue
Staten Island, NY 10303

tel: (718) 816-2000
Contact: Robert Dickson, Environmental Permitting

Procter & Gamble currently purchases all wood fuel used at its 43-MW cogeneration facility plant from haulage contractors and recycled wood waste processors in New York and New Jersey. The plant is burning the waste to produce process steam and electricity. The processed wood specifications are that the moisture content must not exceed 30% (green basis).

Operating Processing Facilities

Hubbard Sand and Gravel, Inc.

1612 5th Avenue
Bayshore, NY 11706

tel: (516) 665-1005
Contact: Mark Kenedy

Hubbard Sand and Gravel presently processes wood wastes on site, for use in a 3-MW cogeneration plant, once it comes on-line. The company is presently stockpiling processed wastes, as final cogeneration equipment decisions are made. The plant does have an electricity sales agreement with LILCO.

SPM Environmental, Inc.
25 Thomas Street
Brooklyn, NY 11222

tel: (718) 963-4445
Contact: Benedict Cutrone

This operating wood waste processing facility produces wood chips from demolition and construction debris supplied by area contractors. The processed wood chips are sold to Procter & Gamble for use as wood fuel at the manufacturing plant on Staten Island.

Star Recycling
50-19 69th Place
Woodside, NY 11377

tel: (718) 651-1930
Contact: A. Lomagino

Star Recycling operates a recycled wood waste processing plant in New York. The company is owned by Allied Sanitation of Woodside, NY. Allied Sanitation hauls and sorts the waste to be burned at the processing facility.

Planned Combustion Facilities

Atlantic Energy Systems, Inc.
Box 4249
Utica, NY 13504

tel: (315) 724-5181
Contact: Bill Glover, President

Atlantic Energy plans to build a 5-MW power plant in Rome, NY that will burn harvested wood chips and recycled wood wastes. The company plans to sell the power Niagara Mohawk, and is in the process of planning the facility, negotiating a power sales agreement and developing the financing package. Atlantic Energy has experience in wood fuel brokering and industrial wood energy design and engineering. They are investigating similar plants for other sites in New York.

Industrial Refuse Systems, Inc.
P.O. Box 333
Croton-on-Hudson, NY 10520

tel: (914) 271-2175

Contact: Robert Liquori

This plant is in the early planning stages, and may both process and burn recycled wood wastes. The goal is to design a facility that will process wood wastes received by a hauling business owned by Liquori and his family, and to install a 3-5 MW cogeneration capacity that will produce power for sale to the local utility and steam for sale, possibly, to a nearby steam-user.

**Pennsylvania
Operating Processing Plant**

Wastewood Recycling Company, Inc.
4300 Rising Sun Avenue
Philadelphia, PA 19140

tel: (215) 455-WOOD
Contact: Andrea Burns

Wastewood Recycling Company is a waste wood processor that produces wood fuel to industrial wood energy users in the local area.

V. MARKET OPPORTUNITIES IN METROPOLITAN BOSTON

V. MARKET OPPORTUNITIES IN METROPOLITAN BOSTON

Approximately 3.7 million tons of solid waste are produced in the metropolitan Boston area extending around Boston through Lawrence and Lowell, Massachusetts and up to Salem, Manchester and Portsmouth, New Hampshire. Over one million tons of the waste are woody materials from demolished buildings, discarded pallets, cardboard containers, refuse from landclearing projects, and wood wastes from other industrial and commercial activities.

In the past, municipal solid waste and other refuse including wood have been disposed of in landfills or incinerated. However, in recent years, the fees charged at landfills and transfer stations have increased dramatically as landfills become full and close. Consequently, towns and industries in the region are seeking alternative methods of disposal.

While much attention has been given to refuse-to-energy plants, a few firms have recently developed wood waste processing plants that produce wood fuel and landscaping mulch from local wastes. The processors convert demolition debris, construction debris, and other wood wastes into wood chips, for sale to local wood-burning facilities, wood chip brokers, and mulch markets. The experience of these facilities demonstrate regional opportunities and constraints for the further processing and use of recycled wood wastes.

Overall, the availability of wood wastes for processing and use depends on a variety of factors, including:

- current waste disposal options,
- future plans to expand waste disposal facilities including landfills, resource recovery operations, and refuse-to-energy plants,
- existing or proposed recycling programs,
- ability and willingness of waste producers and haulers to separate wood from the waste stream,
- availability of wood waste processing and sales businesses, and
- existing and future demand for processed wastes.

Presented below is detailed information on existing and planned waste disposal practices in the greater Boston area, as well as an analysis of opportunities for recycled wood waste processing businesses.

Geographic Area Included in Research and Analysis

Urban and suburban areas in the metropolitan Boston area studied in this research include: greater Boston and surrounding communities including Lawrence and Lowell, Massachusetts and up to Salem, Manchester and Portsmouth, New Hampshire. According to information provided by the U.S. Census Bureau, the population of this area was approximately 4.0 million in 1984.

Volume of Wastes Produced

Substantial research completed nationwide indicates that typical waste production in urban areas of the U.S. range from 5 pounds per day per person to 5.8 pounds per day per person. In order to be conservative in estimates of the volume of wastes available for processing into wood, the lower figure is used for Boston in this report.

Therefore, it is estimated that approximately 3.7 million tons of solid wastes are produced per year in the Boston area. This is an average of 10,100 tons per day.

Availability of Recycled Wood Waste

National data on the rate of wood waste generation per capita can be used to estimate the tonnages of wood wastes produced in this metropolitan area. There are four major sources of recycled wood waste

categories: municipal waste, demolition and construction debris, trees and brush, and yard waste. According to studies for the U.S. Environmental Protection Agency, wood is approximately 4% of the municipal waste stream, equal to 0.12 pounds per capita per day (pcd), or approximately 240 tons per day (tpd) in the greater Boston area. This fraction of available waste wood is usually generated in small amounts at any one source and hence is relatively costly to segregate.

Demolition debris is the largest single source of waste wood. Construction work is also an important source. Nationally, these activities generate wood waste at a rate of 0.55 pcd. This amount translates into approximately 1,100 tpd of demolition and construction wood in and near Boston.

Other waste wood arises from trimming trees and bushes, landscaping, land clearing, and cutting brush. Nationally, yard wastes are estimated to be 0.55 pcd. In addition, maintaining public parks, clearing land and rights of way is estimated to be another 0.18 pcd. Based on these figures, Boston and environs dispose of an average of 1,100 tons of yard waste and 360 tons of tree limbs and brush per day.

These four categories total 1.40 pcd or 2,800 tpd, or just over one million tons per year as shown in Table 1. This estimate may be low because it excludes heavy cardboard or other paperboard wastes that are generated at a rate of about 1.0 pcd. Creosote- and pressure-treated timber are also excluded although these materials arise from the replacement of railroad ties, telephone poles, and piers.

TABLE 1
ESTIMATED AMOUNT OF RECYCLED WOOD WASTE IN GREATER BOSTON

Type	Pounds/Day Per Capita	Tons/Day Boston Area*	Moisture Content (%)
Municipal wood waste	0.12	240	15-20
Demolition & construction debris	0.55	1,100	10-15
Trees and brush	0.18	360	40-50
Yard waste	0.55	1,100	40-50
	<u>1.40</u>	<u>2,800</u>	

*Based on a population of 4,027,000 provided by the U.S. Census Bureau.

[Click here for table in WK1 format.](#)

Current Waste Disposal Practices

Boston area wastes are either landfilled or burned in incinerators and refuse-to-energy plants. According to the Massachusetts Department of Environmental Management, existing landfill capacity in the Boston area is only about 770 tons per day. This seems low, but many landfills in Massachusetts have closed since 1980. Many more are scheduled to close during the next few years. In addition, the New Hampshire Department of Waste Management reports that there are no landfills in operation in Salem and Manchester, and only a few significant ones in operation near Boston.

In addition to landfills, a variety of incinerators and refuse-to-energy plants are in operation in the Boston area. They are listed in Table 2. The plants have the capacity to handle up to 6,348 tons of solid wastes per day.

There are also numerous transfer stations that handle wastes from a wide variety of sources. However, most transfer stations do not have disposal capabilities and must eventually dispose of the wastes in some other way, e.g. at landfills, incinerators, or refuse-to-energy plants. They are therefore not considered as a long-term disposal option in this report.

Rapid increases in tipping fees have taken place in the past five years, at an average annual rate of 50% in some towns near Boston. This is expected to continue into the 1990s. Table 2 shows representative

tipping fees at landfills and transfer stations in eastern Massachusetts and Rhode Island.

Tipping fees charged by Boston area transfer stations depend on fees charged by regional landfills and whether materials are segregated before delivery. Jet-A-Way, a transfer station in Roxbury, Massachusetts charges less for wood wastes that are segregated prior to delivery.

TABLE 2
1987 TIPPING FEES AT AREA LANDFILLS AND TRANSFER STATIONS IN GREATER BOSTON

Landfill	Tipping Fee
Fall River Landfill, Fall River, MA	\$75.00/ton for commercial wastes
BFI/Cambridge Transfer Station, Cambridge, MA	\$100.00/ton
Jet-A-Way, Inc. Transfer Station, Roxbury, MA	\$65.00/ton for segregated wood wastes
Central Landfill, Johnston, RI	\$49.00/ton for commercial wastes

[Click here for table in WK1 format.](#)

TABLE 3
OPERATING RESOURCE RECOVERY FACILITIES IN GREATER BOSTON WITHIN 75-MILE RADIUS

Location	Capacity (tpd)	Energy Products
Fall River, MA	240	None
Haverhill, MA	1,300	Electricity
Millbury, MA	1,500	Electricity
North Andover, MA	1,500	Electricity
Saugus, MA	1,500	Electricity
Durham, NH	108	Steam
Portsmouth, NH	200	Steam

Source: "Waste Age 1987 Refuse Incineration and Waste-to-Energy Listings,"
Waste Age, November 1987.

[Click here for table in WK1 format.](#)

Waste Disposal Options Being Planned or Under Construction

In response to the shortage of disposal space in Boston, a variety of strategies are being pursued. These include increasing the capacity of new or existing landfills, building additional refuse-to-energy capacity, and instituting new recycling efforts.

Although it is not generally believed that substantial new landfills will be developed in Boston in the future, it is important to note that a \$260 million landfill assistance program was launched in Massachusetts in late 1987. The purpose of the program is to provide grants to communities that assist in cleaning up existing landfills and, in some cases, help build new ones. It is not yet known what impact the program will have on landfills in the Boston area.

In addition to possible increases in landfill capacity, there is approximately 3,100 tons per day of new refuse-to-energy capacity permitted or under construction in the Boston area. There is at least another

3,800 tons per day proposed but not yet permitted. It is not clear how definite the proposed plants are and it is not certain that they will all receive the permits required to begin construction and come on-line. Additional resource recovery facilities are being planned in Rhode Island and New Hampshire. A list of proposed refuse-to-energy facilities within a 75-mile radius of Boston is presented in Table 4.

TABLE 4
PROPOSED REFUSE-TO-ENERGY FACILITIES WITHIN 75 MILES OF BOSTON

Location	Capacity (tpd)	Expected Start-Up
Boston, MA	1,500	1990
Hull, MA	150	1991
Mansfield, MA	-	-
Taunton, MA	100	-
Weymouth, MA	300	1989
Rochester, MA	1,800	1988
Concord, NH	500	1989
Derry, NH	200	-
Hudson, NH	400	-
Portsmouth, NH	1,000	1991
Johnston, RI	750	-
Woonsocket, RI	-	-
North Kingstown, RI	750	1990
	<hr/> 6,950	

Source: "Waste Age 1987 Refuse Incineration and Waste-to-Energy Listings,"
Waste Age, November 1987.

[Click here for table in WK1 format.](#)

Interest in recycling programs is expanding in the Boston area as tipping fees and waste disposal costs grow for municipalities, businesses and industries. While there are no comprehensive recycling programs currently in operation, the state of Massachusetts recently announced plans to build a large recycling plant in Boston's South Bay area. This will replace previous plans to build a new incinerator in either Boston or suburban Weston. Details on the recycling plant are not yet complete, but public response has generally been favorable.

Summary of Waste Disposal Options in Metropolitan Boston

In the Boston metropolitan area existing landfill capacity is about 800 tons per day. Incineration and refuse-to-energy capacity is 6,300 tons per day, providing a total waste disposal capacity of 7,100 tons per day.

An average of 10,100 tons of solid waste are produced each day in the area. Approximately 28% of these, or 2,800 tons per day, are wood waste materials. There is currently a shortfall in disposal capacity of about 2,900 tons per day, which is equivalent to 1.1 million tons per year which is transported to out of state landfills.

There are a variety of projects underway that are designed to increase wastes handling and disposal capacity in the area. These include possible increases in landfill capacity, at least 3,100 tons per day in refuse-to-energy capacity, and a variety of plans for increased recycling efforts.

While plans for the future are not certain, it is possible that the increase in refuse-to-energy capacity currently permitted or under construction could offset the shortfall in existing capacity. However, there is not enough capacity planned to handle growth in waste production that could be caused by population increases or continued economic expansion.

Additional new waste disposal capacity or increased recycling efforts will be necessary to handle possible increases in waste production. Although it is not known what the growth in waste production might be, a growth rate of 2% per year has been projected in other sections of the northeast.

The Potential Market for Recycled Wood Waste Processors

There are several ways to analyze the information presented above in a way meaningful and useful to potential wood waste processing businesses. On the one hand, it is clear that there is a significant gap between the amount of waste currently being produced in Boston and existing disposal capacity. This gap is stimulating substantial interest in creating alternative methods of disposal, as public and private decisionmakers propose new recycling plants and refuse-to-energy facilities.

On the other hand, substantial refuse-to-energy capacity is already permitted and, in some cases, under construction. If all of the permitted plants come on-line within the next three to four years, there could be enough capacity to handle the existing shortfall. This would not be true, however, if the volume of wastes produced each year increases significantly.

There are several important points to keep in mind when analyzing the potential for recycled wood waste businesses in the Boston area. First, as noted above, the proposed new capacity can not handle even modest growth in the volume of waste produced. Such growth could occur if the region continues to prosper and increase in size, as it has during the past five years.

Second, numerous existing landfills in the area are due to close during the next 5 to 10 years. This will spur a search for new waste disposal options.

Third, interest in recycling opportunities is increasing as the public becomes more aware of the "solid waste crisis." The public is also becoming more concerned about possible adverse environmental and health effects of the combustion of municipal solid waste, particularly in mass burn facilities. These trends could lead to decisionmaking at the local or state level that favors the development of recycling programs over the development of refuse-to-energy or incineration projects.

Fourth, there is already one business in the Boston area that is actively seeking and processing wood wastes for use as wood fuel and as landscaping mulch. There are several other firms considering similar facilities. Because these facilities tend to be simpler than refuse-to-energy plants, it may be possible for project developers to identify markets and prepare plants for operation more quickly than others.

Fifth, there is substantial and increasing demand for both wood fuel and landscaping mulch in the greater Boston area. The wood fuel market is motivated primarily by the completion of numerous 15- to 20-MW, wood-fired power plants in southern and central New Hampshire in recent years. The mulch marketed is stimulated by the amount of development and housing construction experienced in the area during the past few years. Based on the quality and specifications of recycled wood wastes currently being produced near Boston, it is possible that both markets could be served by recycled wood waste processors in the future. However, fuel-quality chips demand a price premium over landscaping mulch. Processors can expect to receive between \$15 and \$20 per ton for boiler fuel and only \$5 to \$7 per ton for mulch.

Opportunities for Recycled Wood Waste Processors

High tipping fees at disposal facilities and a shortage of solid waste disposal capacity in the Boston area have created opportunities for recycled wood waste processors. As the costs of waste disposal increase, municipalities, businesses and industries seek more cost effective options.

Industries that produce substantial volumes of wood could benefit the most from becoming wood waste processors. If a firm processes waste themselves and uses it to produce thermal or electric energy, the reduction in fuel costs and waste disposal costs can be significant.

Landfill and transfer station operators could also benefit. By segregating wood wastes, a landfill operator can save valuable dump capacity and extend the life of the landfill. Transfer stations can reduce transportation costs to area landfills and incinerators by removing wood from the waste stream. Once

processed, these wood chips can be sold to wood-burning facilities to recoup the production cost.

The opportunities for waste wood processing are not without risk. If new resource recovery facilities accept wood wastes, they may compete with small wood waste processors. To be competitive, processors must charge lower tipping fees than existing landfills or waste-to-energy plants to motivate waste generators, haulers, and landfill and transfer station operators to segregate wood.

The potential to build small-scale, power-generating facilities fired by recycled wood is another possible area to consider. During the early 1990s, New England electric utilities may face a shortage of baseload generation capacity. Most utilities are reluctant to make capital investments in new fossil fuel-fired generating stations. They may seek alternative electric supply sources such as wood-fired electric generation and cogeneration plants.

Existing Recycled Wood Waste Operations

There are currently two recycled wood waste processing plants operating in the Boston-Lawrence-Salem metropolitan area. One facility in southern Maine, has been open since 1986. The second, in New Hampshire, began operation in 1987. The two plants are described below.

Fuel Technologies Inc.
310 Cottage Road
Lewiston, ME 04240

tel: (207)783-2941
Contact: Mark Woodbury, Manager

Fuel Technologies Inc. (FTI), in Lewiston, Maine, converts discarded wood waste into boiler fuel. Unprocessed wood is received at the site from waste generators and haulage contractors within a 100-mile radius. The tipping fee is \$15 per ton.

Typical waste loads include pallets, cable spools, wood demolition debris, and brush. These materials are moved from the dump site to processing and storage areas by a bulldozer. After removing non-wood materials by hand, the wood wastes are hogged by a Jeffrey hammermill and pass through magnets and screens that remove ferrous metals and fines such as soil. Fines are sold to a local landscaping contractor as fill and mulch. The processed wood chips are sold as fuel to two local wood-burning facilities, Maine Energy Recovery Company and Scott Winslow Paper Company. Additional information on FTI is provided in a case study in this handbook.

Granite State Natural Products
51 Main Street
Salem, NH 03079

tel: (603)893-2561
Contact: Dan Breton, Plant Manager
Frank V. Hekimian, Treasurer

Granite State Natural Products (GSNP) is a recycled wood waste processor in Salem, New Hampshire. The facility is designed to shred wood and wood waste materials for use as an industrial fuel. Wood wastes come from waste producers and haulage contractors in the Boston region.

GSNP can hog approximately 500 tons per day. Typical waste loads include demolition debris, construction scraps, prunings and trimmings, and pallets. The processed fuel appears similar to a harvested wood chip but has a moisture content of only 15-20%. The energy content is approximately 9,000 Btu per ton.

The company has developed strict quality control guidelines for wood wastes dumped at the plant site. Each load must be at least 95% wood. Wastes are rejected if asbestos, creosoted materials, concrete

rubble, large metal pieces, rubber or tar shingles are noted. The accepted wood wastes are loaded by a grapple or front-end loader onto a vibrating conveyor where the material is visually inspected while being transported through a magnet. The wood is then conveyed through a 900-pound hammermill, another series of magnets and shaker screens. The processed fuel is loaded into standing trailers or a storage hopper, and sold to wood chip brokers. A case study on GSNP is in the preceding section.

In addition to these two plants, a third waste wood project warrants special mention. Signal Energy Systems, part of the Henley Group is completing negotiations with Boston Edison to build a 25-MW recycled wood-fired power plant near Boston. All the electricity will be sold to Boston Edison. Wood wastes and green tree chips will be employed as fuel. The investment and operations of the plant will be the responsibility of Signal Energy Systems.

Summary

Current waste disposal problems and high tipping fees have created opportunities for wood waste processors in the Boston metropolitan region. Before investing in wood waste processing equipment, it is essential for important market research to be completed. Research should include

- estimating the amount and types of wood wastes available and the tipping fees that must be charged to attract supplies;
- contacting potential markets for wastes, developing contracts for delivery, and determining the price end users will pay for processed wood; (It may be necessary to create markets for the fuel by providing innovative financing arrangements with potential wood-fired facilities or arranging for discounted fuel for a specified period.)
- obtaining an appropriate site for the facility and completing the local and state environmental review process;
- arranging for the technical expertise needed to design and construct a wood waste processing facility; and
- raising the capital needed.

Two firms have begun recycled wood chip processing operations near Boston and are actively seeking new sales outlets. Current buyers include wood-fired power plants and wood chip brokers. Changes in solid waste management practices could improve the economic viability of recycled wood chip operations but site-specific research should be completed for any proposed facility.

VI. MARKET OPPORTUNITIES IN METROPOLITAN NEW YORK CITY

>

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Wood Waste Recycling

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- Intro to Wood Waste
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Intro to Wood Waste

Wood waste, or "secondary wood fiber," as is perhaps more appropriate given the development of value added markets in the northwest, is a major component of C&D and MSW waste streams. There are a variety of end use applications for wood waste, ranging from biofuel use on the low end to pulp and paper applications on the high end. Research suggests that many landfill numbers may not fully reflect quantities of wood waste received, and that some streams of wood waste such as land clearing stumps burned on site may not be counted through either channel. This indicates a larger actual supply of secondary wood fiber available for recycling. Industrial residuals are handled by some recyclers as well.

Developing Markets for Recycled Wood Waste

• Pulp & Paper

Pulp and paper applications in certain parts of the country represent the greatest potential for growth in utilization of secondary wood fiber. Strong prices paid by the industry for typical raw material and the declining supply of virgin pulp chips available, make CDL wood waste sources increasingly attractive as mills struggle to meet long term fiber needs. This use requires very clean material, which means recyclers must be able to process for a number of contaminants, depending on feed material. Secondary wood fiber can provide the longer and stronger fibers needed as mills increase their utilization of shorter waste paper fibers.

• Reconstituted Panelboard

Reconstituted panelboard products also offer potential for CDL wood waste processors. The infrastructure for utilizing material in this application is limited to certain areas of the country. This market generally pays less for feedstock material than pulp and paper producers, but represents a potential fiber application for waste wood materials. The ability of wood waste processors to access any of the fiber market applications, including these and others depends on their ability to supply "clean" material which meets industry specs.

• Other Applications

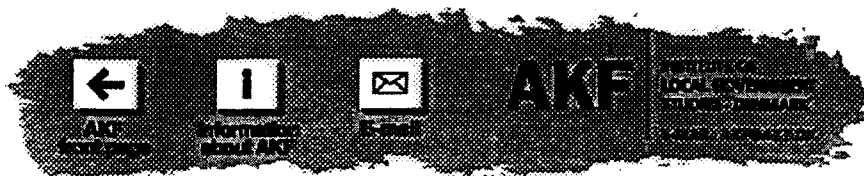
In addition to the high and low value applications for recycled wood waste, a

number of mid-value applications offer potential. Among these are fiber-composite applications, animal bedding, interim road beds, mulch and soil amendments, bulking agents for compost production, chemical derivatives, and processed fuel pellets or blends. Each of these end uses may have value in particular situations. For instance, interim road bed applications may make sense for the utilization of rural land clearing or forest residual wood waste.

- **Biomass Combustion**

This has historically been and continues to be the largest market for recovered wood wastes. Industrial conversion to lower cost fuels such as natural gas and the increased stringency of air quality control requirements will continue to erode demand for hog fuel (biofuel) material. As this market declines, processors will have to find other markets, such as compost, for low grade waste wood chips. The alternative for processors is to make the necessary capital investment to bring chips up to the specifications for higher value markets.





Assessing the »Waste Hierarchy«

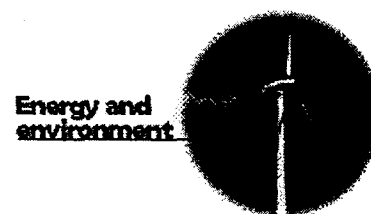
- a Social Cost-Benefit Analysis of Municipal Solid Waste Management in the European Union

Inger E. Brisson

AKF Forlaget. April 1997

3 Cost-Benefit Analysis of MSW Management

The general theory relating to the costs, and benefits, of recycling, incineration and landfilling were set out in section 2. The detail will be presented in this section.



Landfill

For landfill, there are two main elements of costs and benefits:

- a) collection and transport to the landfill;
- b) operation of the landfill.

The costs of the collection and transport of waste are then:

$$NSC_{L,trans} = PC_{L,trans} + EC_{L,trans} \quad [11]$$

where PC denotes private costs and EC is external costs. Subscript »L« denotes landfill, and subscript »trans« denotes collection and transport.

Similarly, the NSC of landfill operation can be expressed as:

$$NSC_{L,op} = PC_{L,op} + EC_{L,op} - EB_{L,op} \quad [12]$$

with the same notation as before, EB denoting external benefit and subscript »op« denoting operation.

Whereas it might be assumed that both the private, and the external benefits, associated with the collection and transport of waste will be zero, this is not necessarily so in the case of landfill operation. If methane gas is extracted from the landfill, and the energy recovered from it, then the latter will displace energy that would otherwise need to be produced on site or purchased from the national grid. Alternatively, it could be sold to the national electricity grid. In either case, the resulting saving or revenue would be deducted from the operation costs, $PC_{L,op}$, such that this would be a net cost. There is also a positive externality associated with the recovery of energy from landfill. If the

energy thus recovered is marginal to the domestic energy supply, it can be assumed to displace a marginal source of energy, and thereby save the environmental costs associated with the generation of that energy. Thus:

$$EB_{L,op} = EB_{L,disp.eng} [13]$$

where the same notation as before applies and subscript »dis.eng.« refers to displaced energy. Equation [12] then becomes:

$$NSC_{L,op} = PC_{L,op} + EC_{L,op} - EB_{L,disp.eng} [14]$$

Note that the external costs of both operation and collection and transport refer to not only the damage costs resulting from pollution but also the disamenity caused by transport and landfill operation.

Incineration In the case of incineration, the two main elements of the net social costs are the collection and transport costs involved in carrying waste to the incinerator, together with the operational costs of the facility. Apart from possible differences in distances, reflecting the geographical scarcity of incinerators, the collection and transport costs of conveying waste to an incinerator, is indistinguishable from the costs of carrying waste to a landfill. Thus, the NSC of the collection and transport of waste for an incinerator is:

$$NSC_{I,trans} = PC_{I,trans} + EC_{I,trans} [15]$$

where the notation is as before and subscript »I« refers to incinerator. The NSC of the operation of an incinerator can similarly be expressed as:

$$NSC_{I,op} = PC_{I,op} + EC_{I,op} - EC_{I,disp.eng} [16]$$

as the same argument with respect to displaced energy, discussed in the case of landfill, applies if energy is recovered from the incineration process. Bringing equations [15] and [16] together gives the expression:

$$NSC_I = PC_{I,trans} + EC_{I,trans} + PC_{I,op} + EC_{I,op} - EC_{I,disp.eng} [17]$$

However, the incineration of waste leaves a residue which will need to be disposed of to landfill⁽¹⁾. This implies that the NSC associated with the transfer from incinerator to landfill and those of landfilling the residue must be added to equation [17]. If the residual fraction is expressed by f ($f < 1$), the addition to [17] becomes:

$$NSC_{I,res,L} = f (PC_{I,res,trans} + EC_{I,res,trans} + PC_{I,res,L} + EC_{I,res,L}) [18]$$

where the subscript »I.res« refers to incinerator residue.

Note, however, that after incineration the residue will be inert and will not contribute to the formation of methane in the landfill, hence no energy can be recovered. It can also be debated whether there will be any externalities associated with the landfilling of the residue given that it is inert. However, the ash is likely to contain concentrations of heavy metals, salts and other toxic substances which, if combining with leachate otherwise forming in the landfill, can form a very potent toxic cocktail⁽²⁾. Thus the total NSC of incineration becomes:

$$NSC_I = PC_{I,trans} + EC_{I,trans} + PC_{I,op} + EC_{I,op} - EC_{I,disp. eng.} + f \cdot (PC_{I, res, trans} + EC_{I, res, trans} + PC_{I, res, L} + EC_{I, res, L}) \quad [19]$$

Recycling

The main elements of the costs and benefits of recycling, as with landfill and incineration, are related to the collection, transport and operation of the facility

$$NSC_R = NSC_{R,trans} + NSC_{R,op} \quad [20]$$

The components of these costs are, however, distinct from those of incineration and landfill in a number of ways.

Collection

All waste, be it for incineration or landfill, is mixed in a generic container (bin, bag or wheelie bin) and collected from the household (kerbside or backyard). This allows a simple collection method, with the refuse vehicles needing only one compartment. However, in the case of recycling, the recyclables can either be brought to bottle banks and other designated collection points, or collected at the kerbside in a »blue box« system. In either case, it requires that the householder separates the recyclable materials from mixed waste and in many cases also according to the type of material. Recyclables in a kerbside collection scheme can either be co-collected with mixed waste or can be collected separately. If it is co-collected, the refuse vehicles must have separate compartments for the recyclables, preferably one each for say, glass, metals and plastics; a requirement which raises collection costs. Unless the refuse vehicles are very sophisticated and fitted with mechanical lifting devices and specialised refuse bins are used, the staff manning the refuse vehicles must transfer the recyclables to the collection vehicle manually, also adding to costs. In the case of bring systems, the collection costs are not only those associated with the vehicle emptying or replacing full bottle banks and other such containers and the transference of those materials to the materials recovery facility (MRF), but also the costs associated with the householder bringing the materials to the designated collection point. If the bottle bank, say, is placed in the supermarket car park, and the householder takes the recyclables to the bank as part of an existing trip, for example when he/she is going shopping anyway, then it appears that no additional costs are incurred. However, if the householder makes a special trip to take bottles or newspapers to the recycling banks, then both financial and environmental costs will be incurred as a result. In addition, the collected recyclables will also need sorting, which can be a very labour intensive process, although new technologies are coming online which can undertake many of the functions. Despite these differences in collection methods, collection and transport of waste for recycling can be represented in a similar way as for landfill and incineration, together with the additional costs associated with the sorting of waste:

$$NSC_{R,trans} = PC_{R,trans} + EC_{R,trans} + PC_{R,sort} + EC_{R,sort} \quad [21]$$

Displaced Virgin Materials Production

For landfill and incineration, the costs of production and pollution from displaced energy were included as a benefit of the operation. In the case of recycling, energy is not displaced directly. However, if the secondary product resulting from recycling displaces virgin product, the costs

associated with the virgin materials production should be credited as a benefit to recycling. This would include any energy use and pollution that might be required in, or result from, virgin materials production. The savings in energy use can be very significant. Thus, it can be asserted that recycling indirectly displaces energy. In addition, the price of the recycled material should be considered on the benefit side. Similarly, any foregone benefits from virgin materials production, such as the revenues from the sale of the product represented by the price of the virgin product, should be counted as a cost of recycling.

$$NSC_{R,op} = PC_{R,op} + EC_{R,op} - R_R - EC_{Vir} - UC_{Vir} \quad [22]$$

where the same notation as before applies, and R_R is the revenue from selling the recycled material, and UC_{Vir} is another displacement effect often ascribed to recycling. The argument goes, that by displacing virgin products by recycled ones, valuable depletable resources used as an input in virgin materials production are saved. User costs can be regarded as a scarcity premium reflecting the future foregone benefits of using a unit of material now rather than later⁽³⁾. As all the materials (or their constituents) in MSW being targeted for recycling, such as tin, steel, aluminium, paper, glass, plastics, are in plentiful supply, it can be argued that the user cost of virgin materials production will be negligible or zero. However, even in those cases where a material is scarce in a physical sense (i.e. limited reserves) and where there are significant user costs, the *external* user cost may still be negligible, as such scarcity will already be reflected in the market price. If this is the case, it would be inappropriate to include the user cost as an externality, as this would amount to double counting.

It is unlikely that 100% »purity« for recyclables can be achieved, and thus there will always be a fraction of the waste (x) going to recycling, which will need to be disposed of by incineration (y) or landfill (z), where $x = y + z < 1$. As for incineration, the disposal of this residue must also be taken into account.

$$NSC_{R,res} = y \cdot \{PC_{trans,R-I} + EC_{trans,R-I} + NSC_{I,op}\} + z \cdot \{PC_{trans,R-L} + EC_{trans,R-L} + NSC_{L,op}\} \quad [23]$$

Thus, the total net social costs of recycling become:

$$NSC_R = PC_{R,trans} + EC_{R,trans} + PC_{R,sort} + EC_{R,sort} + PC_{R,op} + EC_{R,op} - R_R - EC_{Vir} - UC_{Vir} + y \cdot \{PC_{trans,R-I} + EC_{trans,R-I} + NSC_{I,op}\} + z \cdot \{PC_{trans,R-L} + EC_{trans,R-L} + NSC_{L,op}\} \quad [24]$$

When no attempts are made to internalise externalities such as environmental costs, the agents involved in MSW management will only take account of private costs and benefits leading, most likely, to sub-optimal mixes of waste management methods. The »waste hierarchy«, on the other hand, which purports to champion environmental concerns, implicitly suggests that the private costs are immaterial in the quest for the »best« waste management regime. The attraction of the cost-benefit

approach is that it allows the use of a single decision criterion, and aggregates the private and external costs and benefits, in commensurate terms, in ascertaining the relative attractiveness of each MSW management option. Section 4 addresses the problem of estimating the external costs (and benefits) associated with MSW management in the European Union, while section 5 estimates the private or financial costs of MSW management.

Notes

1. In fact, not all the residue must necessarily be landfilled. In Denmark, in 1990, the residue from waste incineration constituted 90 per cent bottom-ash, 9 per cent fly-ash and 1 per cent residue from fluegas cleaning. Whereas it has not been found feasible to recycle the fly-ash and the residue from fluegas cleaning, around 65 per cent of the bottom-ash is used in the construction and road building industry. (Denmark's Ministry of the Environment, 1992).
2. In the United States, incinerator ash is treated as hazardous waste and must not be co-disposed with MSW.
3. The user cost can be calculated by:

$$\frac{P_B - C}{(1 + r)^T}$$

where P_B is the price of the »backstop« technology; C is its cost of extraction and r is the discount rate. T is given by $S/\Sigma Q^T$ where S is total reserves and Q^T is annual output.

1. **Introduction**
2. **The Optimal Mix of Waste Management Methods**
3. **Cost-Benefit Analysis of MSW Management**
4. **External Costs and Benefits of MSW Management**
5. **Financial Costs of MSW Management**
6. **Total Financial and External Costs of MSW Management**
7. **Conclusions**
8. **References**

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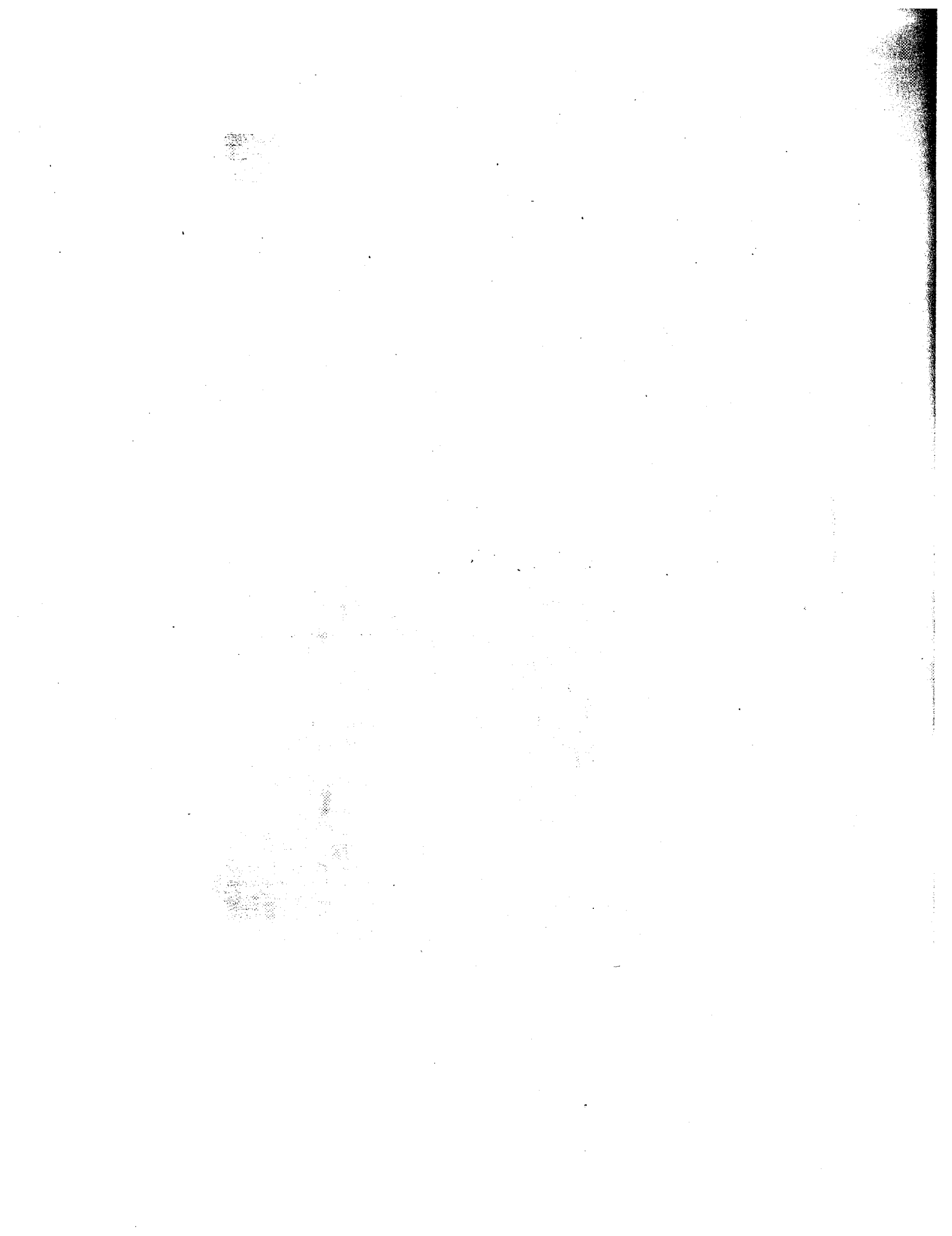
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Company: Eagle Recycled Products	
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% Total Recycled-Content: 100	% Post-Consumer Content: 100

Company: Eaglebrook Products, Inc.	
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Phone: (312) 638-0033	Fax: 312/638-2567
% Total Recycled-Content: 90	% Post-Consumer Content: 100

Company: Earth Care Products of Tennessee	
Mailing Address: P.O. Box 537 Sharon Indl Pk Sharon, TN 38255-0537 ATTN: Tom Brock	
Phone: (901) 456-2681	Fax: 901/456-2252
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Phone: (704) 878-2582, (800) 653-2784	Fax: 704/878-2160
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Company: Engineered Wood Products	
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% Total Recycled-Content: 100	% Post-Consumer Content: 75

Company: Environmental Plastics of Puerto Rico, I	
Mailing Address: P.O. Box 2345 Toa Baja, PR 00951 ATTN: Nicholas Apostol	
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Phone: (909) 390-8800	Fax: 909/390-8700
% Total Recycled-Content: 100	% Post-Consumer Content: 100

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Company: Mobil Chemical Company	
Mailing Address: P.O. Box 5445 Norwalk, CT 06856 ATTN: Kevin Porter	
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Company: N.E.W. Plastics Corporation	
Mailing Address: P.O. Box 220 Luxemburg, WI 54217 ATTN: Lonnie Vincent	
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% Total Recycled-Content: 100	% Post-Consumer Content: 90

Company: Plastic Pilings Inc.	
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Phone: (909) 989-7685	Fax: 909/944-6842
% Total Recycled-Content: 100	% Post-Consumer Content: 50

Company: Plastic Recycling Inc.	
Mailing Address: 10252 Hwy 65 Iowa Falls, IA 50126-8823 ATTN: Regina Lents	
Phone: (515) 648-5073, (800) 338-1438	Fax: 515/648-5074
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Company: Recycled Plastics Industries Inc.	
Mailing Address: 1820 Industrial Dr Green Bay, WI 54302 ATTN: Lee Anderson	
Phone: (414) 468-4545	Fax: 414/468-4765
% Total Recycled-Content: 100	% Post-Consumer Content: 100

Company: Recycled Plastics Marketing Inc.	
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Phone: (206) 867-3200	Fax: 206/867-3282
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Company: The Plastic Lumber Co., Inc.	
Mailing Address: 540 S Main St, Bldg 7 Akron, OH 44311 ATTN: Alan E. Robbins	
Phone: (216) 762-8989	Fax: 216/762-1613
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% Total Recycled-Content: 100	% Post-Consumer Content: 100

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% Total Recycled-Content: 100	% Post-Consumer Content: 100

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